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DEVELOPMENT OF COLLABORATIVE FORECASTING PLANNING LOGISTICS AND REPLENISHMENT MODEL FOR ORCHID SUPPLY CHAIN IN IN THE GREAT BANGKOK METROPOLITAN, THAILAND

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ABSTRACT

This research aimed develop the model of CFPLR for orchid supply chain and investigate supply chain performance from source to end customer for orchid supply chain in order to increase orchid supply chain performance and efficiency. The scope of this research was to focus on the orchid supply chain in the Great Bangkok Metropolitan, and specify only a particular type of orchid grown in Thailand. This research was designed as mixed method. In-depth interview was conducted with several companies in different industries to create CFPLR model. Supply chain performance measurement was created based on SCOR model. A questionnaire was developed to identify and assess supply chain cost in relation with supply chain performance. Data was collected through questionnaire survey. The population for this research was orchid stakeholders. Convenience sampling was employed and the sample size was 50 companies, ranging from source to delivery to customer. The result of the data analysis revealed that there were some correlations between supply chain performance and cost. CFPLR model proposed in this research provides an important roadmap to guide execution across all points of the orchid supply chain and the supply chain performance tracked can be used as key learning to help improve future collaboration plan.

INTRODUCTION

Orchid is an important flower for Thai economy. In 2019, Thailand exported 6.89 USD worth of orchid with the cultivation area of 22,576 rai (8926 acre) and the output of 51,112 tons (DITP, 2020). Since 2016, orchid export in Thailand has been increasing (DITP, 2020). The dendrobium orchid is most preferred for export because of its color, length and freshness (VanZile, 2012). Thailand is the number one producer and exporter of dendrobium orchid (PRD, 2018). The dendrobium orchid is used in many ceremonies and festivals because it is long, fresh and cheap; therefore, demand of dendrobium orchid has been rising for both local consumption and export. Areas where cultivation of orchid is the highest is in the central region as the climate and geography of the central region are suitable for orchid cultivation. Transportation of orchid can also be carried out swiftly and conveniently in the central region. The top 5 orchid cultivation areas are in Nakhon Pathom, Samut Sakhon, Ratchaburi, Bangkok and Kanchanaburi (DITP, 2020). Top 5 export markets for Thai orchid are Japan, United State of America, Vietnam, China and India (DITP, 2020).

Currently, orchid export is becoming highly competitive since the world’s value of orchid has been increasing and more new players are entering the market. However, production cost has been rising and Thailand’s big orchid export competitors have developed competitive advantages and competencies which allow them to strongly compete in the market. For example, Singapore has incorporated their advanced IT system in the orchid production processes and Taiwan has focused on transportation system to cut costs and improve efficiency. As a result, it is important to explore factors affecting Thai orchid export to improve Thai orchid export processes and maintain the top position in orchid export market.

To improve Thai orchid export processes, Supply Chain Management can be applied. Supply Chain Management (SCM) is a strategy that manages processes in supply chain from raw material acquisition to delivery of finished goods to the end users. These processes are procurement, manufacturing, storage, information technology, logistics, human resource competency. All processes are different and difficult to manage, particularly, value chain supporting. One significant tool that can be employed in SCM is CPFR model. CPFR stands for Collaborative Planning, Forecasting and Replenishment. According to the CPFR model developed by Voluntary Interindustry Commerce Standards (VICS), it has been studied and researched in various industry such as retail (Chang et al., 2007), manufacturing (Toiviainen and Hansen, 2011), manufacturer - retailer multi-level (Jiajuan et al., 2010), information system (Liu and Ji, 2010), IT-supported vertical arrangement (Kim and Mahoney, 2006), inbound logistics of automotive industry (Liu and Sun, 2012), inventory model (Chiu and Hsu, 2006), and procurement of agricultural products (Du et al., 2009). The CPFR model has not been widely studied and applied in a whole supply chain of agricultural product such as orchid. Only Du et al (2009) sought to apply the framework of collaborative planning, forecasting and replenishment (CPFR) to develop a procurement model for agricultural products. Considering the biological nature, seasonality and perishable characteristics of agricultural raw materials and products, this research will revise the CPFR reference model, construct a n-tier CPFR procurement model by extending a two-echelon supply chain to a multi-echelon supply chain and incorporate upstream suppliers in the supply chain. Thus, this research will apply the new model that is Collaborative Forecasting, Planning, Logistics and Replenishment (CFPLR) in orchid supply chain. This will result in improving Thai orchid supply chain, increasing competitive advantage and developing new competencies. In addition, by improving orchid supply chain, it will reduce the logistics cost which is one of major costs in supply chain. Apichat Jongsakul mentioned in the seminar of developing strategy in logistics and supply chain system for agricultural industry (year 2013 – 2016) that the logistics cost for the agricultural industry is approximately 21 – 25% above the overall logistics cost at 15% per gross domestic product. This is also in line with Strategy 7 of the 12th National Economic and Social Development Plan which focuses on improving transportation and logistics to increase the country's competitiveness (NESDC, 2017). This research aimed to 1) identifying the rationale behind of orchid supply chain problem, especially for agricultural products, 2) develop the model of CFPLR for orchid supply chain, 3) investigate supply chain performance from source to end customer and 4) identifying cost of orchid supply chain. By developing the model of CFPLR for orchid supply chain, it can provide a roadmap in increasing collaboration and integrating orchid supply chain. Examining supply chain performance can help increase efficiency in orchid supply chain.

LITERATURE REVIEW

Supply Chain Management (SCM) involves planning and management of all supply chain activities from suppliers, manufacturers, retailers/wholesales to consumers which are sourcing and procurement, conversion, and all logistics management (Somjai & Jermsittiparsert, 2019). Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers and customers. Supply Chain Management is an integrating function with primary responsibility of linking major business functions and business processes within and across companies into a cohesive and high-performing business model. It includes all of the logistics management activities noted above, as well as manufacturing operations. It also drives coordination of processes and activities with and across marketing, sales, product design, finance and information technology.

Supply Chain Management (SCM) was developed to express the need to integrate the key business processes, from end users to original suppliers. The basic idea behind SCM is that companies and corporations involve themselves in a supply chain by exchanging information regarding market fluctuations and production capabilities. If all relevant information is accessible to any relevant company, every company in the supply chain has the ability to help optimize the entire supply chain rather than sub optimize based on a local interest. The study of Namdej et al. (2019) showed that sharing of relevant information using technology results in better integration and coordination among companies leading to increase in efficiency. This will lead to better planned overall production and distribution which can cut costs and provide a more attractive final product leading to better sales and better overall results for the companies involved. The study of Ramanathan (2014) revealed that by integrating supply chain and collaborating with supply chain partners in the same business for a long period of time, it can result in increasing financial and operational performance of business.

In Supply Chain Management, SCOR (Supply Chain Operations Reference) model is commonly used to measure total supply chain performance. It was developed by the supply chain council. It is a process reference model for supply chain management, spanning from the supplier's supplier to the customer's customer (ASCM, 2020). It includes delivery and order fulfillment performance, production flexibility, warranty and returns processing costs, inventory and asset turns, and other factors in evaluating the overall effective performance of a supply chain. SCOR model combines elements of business process, engineering, benchmarking, and leading practices into a single framework. Under SCOR model, supply chain management is defined as these integrated processes: Plan, Source, Make, Deliver, and Return which are aligned with a company’s operational strategy, material, work, and information flow. Using SCOR model is beneficial in Supply Chain Management as it can be used to identify supply chain problems, create roadmap to improve supply chain processes and aligning business functions (NC State University, 2020). SCOR model has been researched and applied to various businesses and industries and has been proven to be a highly versatile and effective tool in managing supply chain performance. Based on the SCOR model, Ren at al. (2006) presented a comprehensive framework for supply chain performance management, which includes all aspects of performance management from performance measurement to performance improvement. The framework can be used for supply chain diagnosis, supply chain transformation, and the exploration for supply chain operational mechanisms. Han and Chu (2009) integrated the concepts of the supply chain, a collaborative product commerce, and SCOR model to propose the collaborative supply chain operations reference model (CSCOR) in the product life cycle. This model consists of four hierarchical levels: collaborative business model, collaborative cooperative model, collaborative process model, and a collaborative operational model. This study also applied CSCOR and implemented a system in the electronics industry, which serves as an example of best practices for a collaborative supply chain involving customers, manufacturer, contract firms and suppliers.

Successful Supply Chain Management requires not only total supply chain integration, it also requires collaboration between trading partners in order to increase supply chain efficiency. Collaborative Planning, Forecasting and Replenishment (CPFR) Model is one of the most effective tools in enhancing collaboration among supply chain partners. CPFR initiative began in 1995 and the pilot implementation occurred in 1996. By 1998, most firms started to implement CPFR. It was developed by Voluntary Interindustry Commerce Standards Committee (VICS). VICS has established standard guidelines for CPFR and continued to lead research and implementation of CPFR through its guidelines and project investigations. CPFR serves as a roadmap of supply chain collaboration and helps standardize production planning and product movement in supply chain. CPFR enables firms to share information with their suppliers and customers, develop more accurate forecasts and improve operational and product replenishment processes (Hill, 2018). Various studies were conducted to comprehend how CPFR is used and applied in businesses and industries and highlight benefits of employing CPFR. Danese (2006) found that CPFR can be modified and applied in many industries. The 7 case studies from different sectors are analyzed and 6 important factors were explored which are CPFR goals, characteristics of the products and markets, supply network's physical and relational structure, and CPFR development stage. Du and et al. (2009) applied the modified CPFR process model into agricultural products that reduced inventory variances and increase service level. Caridi et al. (2005) studied CPFR process by several experiments with simulation tool that focuses on agents in the same supply chain. Most of them collaborated in exchanging sales and order forecasting. The result showed the benefits of CPFR process. There was cost, inventory and stock-out and sales reduction of trading partner in the same supply chain.

Despite the benefits of CPFR, it is still slowly adopted. Småros (2002) described that the Collaborative Planning Forecasting and Replenishment (CPFR) model, developed by the Voluntary Inter-Industry Standards (VICS) association, had received significant attention from both practitioners and academics. Despite promising pilots, the adoption rate of CPFR has been slower than expected, especially in Europe. The reason seems to be that the proposed collaboration process is currently too labor-intensive for many European companies. There is a need for streamlined approaches to get collaboration started in Europe. In addition, McCarthy and Golicic (2002) found that CPFR is too large to be fully implemented and lacks detailed activities. Therefore, employment of CPFR can sometimes be difficult.

An increasing number of studies have shown benefits of CPFR. CPFR can reduce inventory. Pfeifer et al. (2008) stated that due to CPFR amongst retailers or manufacturers and their suppliers, decreased inventory and better visibility can be achieved within the supply chain. CPFR can help firms improve performance. Hill (2018) showed that CPFR firms have high sales than non-CPFR firms. CPFR firms also have better operational and financial performance.

RESEARCH METHODOLOGY

This research was designed as mixed method. The CFPLR was developed based on literature review of CPFR model. Additional parameters had to be determined in order to extend CPFR model into the CFPRL model. In-depth interviews were conducted with 5 companies in agricultural, automotive, textile, plastic, and service industries to determine the parameters. CPFR measurement of orchid supply chain that monitors all vendors in supply chain was identified. Variables for SCOR model (supply chain performance measurement) were developed and a questionnaire was created. The questionnaire was tested with IOC and distributed to sample group. Variables for supply chain cost were identified. CFPRL model was verified with a case study of orchid supply chain. SCOR model was assessed using questionnaire survey and supply chain cost was evaluated. For the questionnaire survey, the population was mainly orchid growers, distributors, or retailers located in Thailand. Sampling technique employed was convenience sampling and the sample size was 50 companies, ranging from source to delivery to customer. Quantitative data analysis of supply chain performance and supply chain cost was performed using Statistical Package for the Social Sciences (SPSS). Mean and Standard Deviation were used to assess supply chain performance attributes and Pearson's Correlation was employed to analyze the relationship between supply chain performance and supply chain cost.

RESEARCH RESULTS

CFPRL Model for orchid supply chain

The CFPLR model is defined as "two or more chain members working together to create competitive advantages through sharing information, making joint decisions, and sharing benefits which results in greater profitability from satisfying end customer needs than acting alone" (Simatupang & Sridharan, 2005). It is adapted from CPFR (VICS, 2004) that is applied in logistics management. There are 9 steps that focus on improving accuracy of order and sale forecast, logistics and supply chain management and replenishment. This model requires cooperation in supply chain activities with Information Technology. In addition, supply chain and logistics management highlight network which includes upstream to downstream or suppliers to end users. Cooperation is data and information sharing such as order planning, inventory management, production, transportation and delivery. These can increase efficiency and performance of business such as accurate data interchange, low costs and high profits, and reduce uncertainty along the supply chain. It can be seen that CFPLR can support stakeholders to maximize profits, and customer royalty in long term. Additional parameters were determined in order to extend CPFR model into CFPRL model applicable for orchid supply chain.

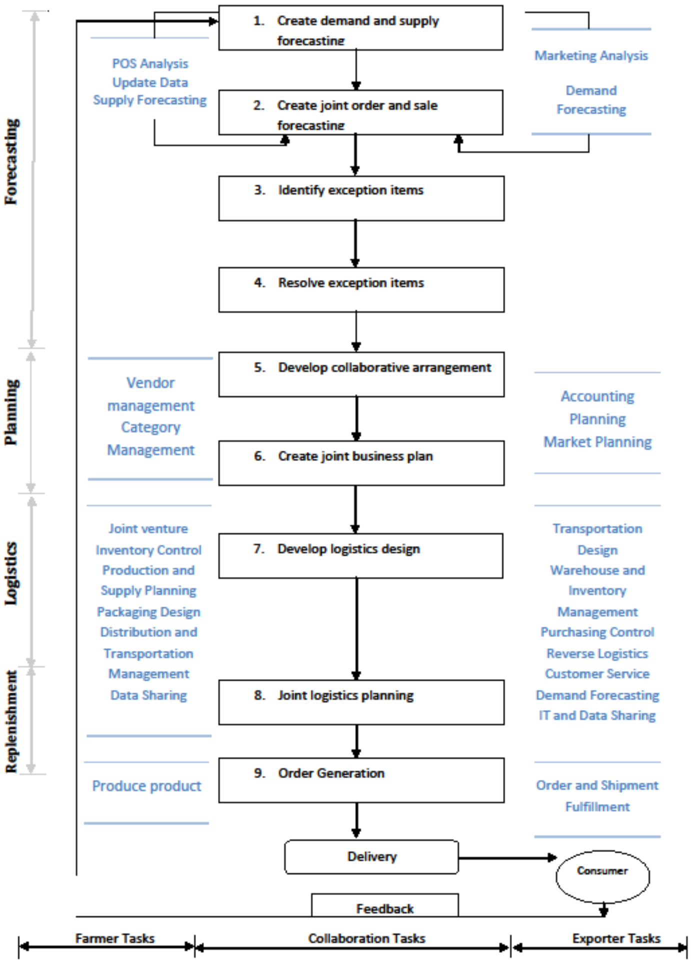

Figure 1: *Proposed CFPLR Model*

Supply Chain Performance Measurement

Five core supply chain performance attributes were identified based on SCOR model which are reliability, responsiveness, agility, costs, and assets. The results were shown as follows:

Table 1*:* Mean and Standard Deviation of Five Core Supply Chain Performance Attributes

			Mean	**Standard Deviation**
Reliability	Plan	1. Demand forecasting of products throughout supply chain	3.09	1.26
		2. Accuracy of demand forecasting of products	3.16	1.34
		3. Demand forecasting of	3.49	1.26

		customers throughout supply chain		
		4. Accuracy of demand forecasting of customers	3.18	1.19
		5. Inventory Forecasting	3.33	1.20
		6. Accuracy of inventory forecasting	3.13	1.24
		7. Demand forecasting of maintenance, repair, and operation items	3.22	1.28
		8. Accuracy of demand forecasting of maintenance, repair, and operation items	3.09	1.38
		9. Demand forecasting of production resources (labor or capital)	3.16	1.49
		10 .Accuracy of demand forecasting of production resources (labor or capital)	3.24	1.54
		11. Demand forecasting of warehouse resources	2.96	1.61
		12. Accuracy of demand forecasting of warehouse resources	2.91	1.72
		13. Demand forecasting of transportation resources	3.22	1.83
		14. Accuracy of demand forecasting of warehouse resources	3.53	1.95
		15. Product delivery in a certain period of time	3.49	1.76
		16. Managing a plan of returned products from customers	3.22	2.05
		17. Managing a plan of returned raw materials to suppliers	3.18	2.19
		18. Managing a plan of information and communication technology for suppliers, farms, transportation companies, export/import companies, and customers	3.27	2.21
	Source	1. Errors incurred during inspection process and raw	3.56	1.13

		material handlings		
		2. On-time delivery of suppliers	3.16	1.22
		3. On-time delivery of payment to suppliers	2.93	1.12
		4. Status evaluation of suppliers (quality, performance, service, on-time delivery, etc.)	3.56	1.17
		5. On-time delivery in delivering products to customers	3.02	1.34
	Make	1. Production planning	3.07	1.16
		2. Accuracy of production planning	3.27	1.20
		3. Production shutdown due to stock out (percentage of shutdown number)	3.22	1.07
		4. Production shutdown due to defects (percentage of shutdown number)	3.07	1.13
	Deliver	1. Accurate delivery of products according to customer order	3.09	1.15
		2. Damages incurred due to delivery	3.33	1.23
		3. On-time delivery in issuing a customer invoice	3.13	1.24
Responsiveness	Plan	1. Time to adjust delivery plan in case of order processing changes	1 Day	-
	Source	1. Frequency of raw materials procurement	156 Number/Year	-
		2. Time to release until receive an order from suppliers	1 Day	-
		3. Duration of raw materials procurement from new sources	1 Day	-
		4. Attention paid from suppliers to quick order fulfillment	2.93	1.17
	Deliver	1. Time to deliver products in domestic	1 Day	-

		2. Time to deliver products in overseas	3 Days	-
		3. Frequency of products delivery in domestics	104 Number/Year	-
		4. Frequency of products delivery in overseas	52 Number/Year	-
	Return	1. Having a service to customers in case of returned products	3.13	1.38
Agility	Plan	1. Time to adjust an order processing plan in case of changed quantity requirements	1 Day	-
		2. Time to adjust an order processing plan in case of changed delivery time	1 Day	-
		3. Having a plan to outsource additional delivery companies in case of additional quantity of orders	3.53	1.17
	Source	1. Time to release an order in case of an urgent requirement	1 Day	-
		2. Attention paid from suppliers to an urgent order processing	3.02	1.15
	Deliver	1. Time to deliver products in domestic	1 Day	-
		2. Time to deliver products in overseas	3 Days	-
		3. Ability to changed quantity of products delivered in relevant to customer requirements	3.16	1.17
	Return	1. Policy in returning defective products by suppliers (from producers)	3.36	1.24
		2. Policy in returning defective raw materials by producers (from customers)	3.02	1.38
Cost	Plan, Source	1. Supply chain management cost	940,000 Baht	

	Make	1. Cost of goods sold	450,000 Baht	-
		2. Value-added productivity	50,000 Baht	-
	Return	1. Warranty cost or returns processing cost	30,000 Baht	-
Asset	Plan	1. Having outsourcing of information system	3.02	1.34
	Source	1. Payment made to suppliers until receiving money from customers	180,000 Baht	-
	Make	1. Cut-Flower orchids	40 %	-
		2. Flask orchids	60 %	-
	Deliver	1. Truck	100 %	-
		2. Truck connecting with train	0 %	-
		3. Truck connecting with airplane	50 %	-
		4. Transportation cost/number	2,500 Baht	-
	Return	1. Returned product from customers	3.07	1.26
		2. Cost of damaged product/turn	1,000 Baht	-

For reliability, an average score of Plan, Source, Make, and Deliver was between 3 and 4 of Likert Scale. This shows that all vendors did not fulfill a performance level as best practices, and there should be an improvement. For responsiveness, data was collected as quantitative analysis. It should be noted that time to adjust delivery plan in case of order processing changes, time to release until receiving an order from suppliers, duration of raw materials procurement from new sources, and time to deliver products in domestic was only 1 day. Nonetheless, time to deliver products to overseas was nearly 3 days. Data was also quantitatively collected for agility. Time to adjust an order processing plan in case of changed quantity requirements, time to adjust an order processing plan in case of changed delivery time, time to release an order in case of an urgent requirement, and time to deliver products in domestic was also 1 day. Delivering orchids requires speed to reduce decomposition of orchids because their short life cycle. Moreover, a policy in returning defective products by suppliers (from producers) and returning defective raw materials by producers (from customers) was approximately 3 days. In terms of cost, supply chain management cost equals to 940,000 Baht, cost of goods sold equals to 450,000 Baht, value-added productivity equals to 50,000 Baht, and warranty cost or returns processing cost equals to 30,000 Baht. Similarly, asset utilization was analyzed and summarized as follows: payment made to suppliers until receiving money from customers equals to 180,000 Baht, cut-flower orchids equals to 40 %, and flask orchids equals to

60 %. Delivering orchids was done by means of truck, truck connecting with train, truck connecting with airplane of 100%, 0%, and 50%, respectively. The cost of transportation per number equals to 2,500 Baht.

Supply Chain Cost

Supply chain cost is a discrete measure defined as fixed and operational costs associated with supply chain processes linking from upstream to downstream. Supply chain costs takes into account:
1) Order Management Cost (Customer Service, Finished Goods Warehouse, Outbound Transportation, Contract and Program Management, Installation Planning and Execution, Accounts Receivable)
2) Material Acquisition Cost (Purchasing, Raw Material Warehouse, Supplier Quality, Component Engineering and Tooling, Inbound Transportation)
3) Planning Cost (Demand Planning, Supply Planning, Supply Chain Finance)
4) Inventory Carrying Cost (Opportunity, Obsolescence, Shrinkage, Taxes and Insurance)
5) IT Cost for Supply Chain (Supply Chain Application, IT Operation for Supply Chain)

Monthly supply chain cost can be divided as follows:

Table 2: Supply Chain Cost Analysis

	Level One Metric		**Calculation Components**		
	Description	**Data (Percentage)**	**Data (Baht)**	**Description**	**Query Assumptions**
Supply Chain Cost	Order Management Cost	40.177	47,667	Customer Service Cost	-
			110,000	Finished Goods Warehouse Cost	Rental cost of nearby warehouses is paid
			141,667	Outbound Transportation Cost	-
			25,000	Contract and Program Management Cost	-
			15,000	Installation Planning and Execution Costs	-
			38,333	Accounts Receivable Cost	Most of customers pay by cash
	Material	47.234	6,000	Purchasing	-

	Acquisition Cost			Cost	
			280,000	Raw Material Warehouse Cost	-
			23,667	Supplier Quality Cost	Quality inspection is made
			12,667	Component Engineering and Tooling Cost	-
			121,667	Inbound Transportation Cost	-
	Planning Cost	2.234	5,500	Demand Planning Cost	-
			4,000	Supply Planning Cost	-
			11,500	Supply Chain Finance Cost	-
	Inventory Carrying Cost	9.752	0	Opportunity Cost	N/A
			56,667	Obsolescence Cost	Orchids has a short life cycle so some can be obsolescent
			0	Shrinkage Cost	N/A
			35,000	Taxes and Insurance Cost	-
	IT Cost for Supply Chain	5.283	14,667	Supply Chain Application Cost	-
			35,000	IT Operation Cost for Supply Chain	Only a barcode system is provided

Supply chain cost analysis can be summarized as order management cost which is 40.17%, material acquisition which as 47.234%, planning cost which is 2.234%, inventory carrying cost which is 9.52% and IT cost for supply chain which is 5.283%. This supply chain cost was calculated on a monthly basis as the fixed and operational costs associated with the supply chain processes linking from upstream to downstream.

Association of supply chain performance with supply chain cost

The relationship between the interdependent variables and dependent variables was examined using Pearson's correlation**.** The independent variables were supply chain performance attributes which are reliability, responsiveness, agility, costs, and assets and the dependent variables were supply chain costs which are order management cost, material acquisition cost, planning cost, inventory carrying cost, and IT cost for supply chain. The results were shown in Table 3.

- Finished goods warehouse cost (FGWC) was negatively associated with demand forecasting of maintenance, repair, and operation items (RLP7) ($r = -1.000$, $\rho = 0.000$, $N = 3$).
- Outbound transportation cost (OTC) was negatively associated with inventory forecasting (RLP5) ($r = -1.000$, $\rho = 0.000$, $N = 3$).
- Outbound transportation cost (OTC) was positively associated with accuracy of demand forecasting of maintenance, repair, and operation items (RLP8) ($r = 1.000$, $\rho = 0.000$, $N = 3$).
- Contract and program management cost (CPMC) was negatively associated with Demand forecasting of maintenance, repair, and operation items (RLP7) ($r = -1.000$, $\rho = 0.000$, $N = 3$).
- Installation planning and execution costs (IPEC) was negatively associated with Demand forecasting of maintenance, repair, and operation items (RLP7) ($r = -1.000$, $\rho = 0.000$, $N = 3$).
- Accounts receivable cost (ARC) was negatively associated with demand forecasting of production resources (labor or capital) (RLP9) ($r = -1.000$, $\rho = 0.000$, $N = 3$).
- Accounts receivable cost (ARC) was negatively associated with demand forecasting of transportation resources (RLP13) ($r = -1.000$, $\rho = 0.000$, $N = 3$).
- Purchasing Cost (PC) was negatively associated with demand forecasting of maintenance, repair, and operation items (RLP7) ($r = -1.000$, $\rho = 0.000$, $N = 3$).
- Demand planning cost (DPC) was negatively associated with demand forecasting of maintenance, repair, and operation items (RLP7) ($r = -1.000$, $\rho = 0.000$, $N = 3$).
- Supply planning cost (SPC) was positively associated with demand forecasting of maintenance, repair, and operation items (RLP7) ($r = 1.000$, $\rho = 0.000$, $N = 3$).
- Taxes and insurance cost (TIC) was positively associated with demand forecasting of products throughout supply chain (RLP1) ($r = 1.000$, $\rho = 0.000$, $N = 3$).
- Taxes and insurance cost (TIC) was positively associated with accuracy of demand forecasting of customers (RLP4) ($r = 1.000$, $\rho = 0.000$, $N = 3$).
- Taxes and insurance cost (TIC) was positively associated with accuracy of demand forecasting of production resources (labor or capital) (RLP10) ($r = 1.000$, $\rho = 0.000$, $N = 3$).
- IT operation cost for supply chain (IOCSC) was negatively associated with demand forecasting of maintenance, repair, and operation items (RLP7) ($r = -1.000$, $\rho = 0.000$, $N = 3$).
- Outbound transportation cost (OTC) was positively associated with managing a plan of returned products from customers (RLP16) ($r = 1.000$, $\rho = 0.000$, $N = 3$).

- Accounts receivable cost (ARC) was positively associated with errors incurred during inspection process and raw material handlings (RLS1) ($r = 1.000$, $\rho = 0.000$, $N = 3$).
- Accounts receivable cost (ARC) was negatively associated with on-time delivery in delivering products to customers (RLS5) ($r = -1.000$, $\rho = 0.000$, $N = 3$).
- Accounts receivable cost (ARC) was negatively associated with production shutdown due to stock out (percentage of shutdown number) (RLM3) ($r = -1.000$, $\rho = 0.000$, $N = 3$).
- Obsolescence cost (OBC) was negatively associated with production planning (RLM1) ($r = -1.000$, $\rho = 0.000$, $N = 3$).
- Taxes and insurance cost (TIC) was positively associated with managing a plan of returned raw materials to suppliers (RLP17) ($r = 1.000$, $\rho = 0.000$, $N = 3$).
- Taxes and insurance cost (TIC) was negatively associated with status evaluation of suppliers (quality, performance, service, on-time delivery, etc.) (RLS4) ($r = -1.000$, $\rho = 0.000$, $N = 3$).
- Finished goods warehouse cost (FGWC) was negatively associated with having a service to customers in case of returned products (RSR1) ($r = -1.000$, $\rho = 0.000$, $N = 3$).
- Outbound transportation cost (OTC) was negatively associated with attention paid from suppliers to quick order fulfillment (RSS4) ($r = -1.000$, $\rho = 0.000$, $N = 3$).
- Outbound transportation cost (OTC) was negatively associated with policy in returning defective products by suppliers (from producers) (AGR1) ($r = -1.000$, $\rho = 0.000$, $N = 3$).
- Outbound transportation cost (OTC) was negatively associated with policy in returning defective raw materials by producers (from customers) (AGR2) ($r = -1.000$, $\rho = 0.000$, $N = 3$).
- Outbound transportation cost (OTC) was negatively associated with having outsourcing of information system (ASP1) ($r = -1.000$, $\rho = 0.000$, $N = 3$).
- Contract and program management cost (CPMC) was negatively associated with having a service to customers in case of returned products (RSR1) ($r = -1.000$, $\rho = 0.000$, $N = 3$).
- Installation planning and execution costs (IPEC) was negatively associated with having a service to customers in case of returned products (RSR1) ($r = -1.000$, $\rho = 0.000$, $N = 3$).
- Accounts receivable cost (ARC) was negatively associated with attention paid from suppliers to an urgent order processing (AGS2) ($r = -1.000$, $\rho = 0.000$, $N = 3$).
- Purchasing cost (PC) was negatively associated with having a service to customers in case of returned products (RSR1) ($r = -1.000$, $\rho = 0.000$, $N = 3$).
- Demand planning cost (DPC) was negatively associated with having a service to customers in case of returned products (RSR1) ($r = -1.000$, $\rho = 0.000$, $N = 3$).

- Supply planning cost (SPC) was positively associated with having a service to customers in case of returned products (RSR1) (r = 1.000, ρ = 0.000, N = 3).
- Obsolescence cost (OBC) was negatively associated with production shutdown due to defects (percentage of shutdown number) (RLM4) (r = -1.000, ρ = 0.000, N = 3).
- Taxes and insurance cost (TIC) was positively associated with ability to changed quantity of products delivered in relevant to customer requirements (AGD3) (r = 1.000, ρ = 0.000, N = 3).
- IT operation cost for supply chain (IOCSC) was negatively associated with having a service to customers in case of returned products (RSR1) (r = -1.000, ρ = 0.000, N =

From the results, it can be concluded that there were some correlations between supply chain performance and cost.

Table 3: Pearson's Correlation between Supply Chain Performance and Supply Chain Cost

		RLP1	**RLP2**	**RLP3**	**RLP4**	**RLP5**	**RLP6**	**RLP7**	**RLP8**	**RLP9**	**RLP10**	**RLP11**	**RLP12**	**RLP13**
FGWC	**Pearson Correlation**	.500	.000	-.982	.500	.655	.500	-1.000**	-.655	.866	.500	.[a]	.000	.866
	Sig. (2-tailed)	.667	1.000	.121	.667	.546	.667	.000	.546	.333	.667	.000	1.000	.333
	N	3	3	3	3	3	3	3	3	3	3	3	3	3
OTC	**Pearson Correlation**	-.982	-.756	.786	-.982	-1.000**	.327	.655	1.000**	-.189	-.982	.[a]	.756	-.189
	Sig. (2-tailed)	.121	.454	.425	.121	.000	.788	.546	.000	.879	.121	.000	.454	.879
	N	3	3	3	3	3	3	3	3	3	3	3	3	3
CPMC	**Pearson Correlation**	.500	.000	-.982	.500	.655	.500	-1.000**	-.655	.866	.500	.[a]	.000	.866
	Sig. (2-tailed)	.667	1.000	.121	.667	.546	.667	.000	.546	.333	.667	.000	1.000	.333
	N	3	3	3	3	3	3	3	3	3	3	3	3	3
IPEC	**Pearson Corre**	.500	.000	-.982	.500	.655	.500	-1.000*	-.655	.866	.500	.[a]	.000	.866

	lation							*						
	Sig. (2-tailed)	.667	1.000	.121	.667	.546	.667	.000	.546	.333	.667	.000	1.000	.333
	N	3	3	3	3	3	3	3	3	3	3	3	3	3
ARC	**Pearson Correlation**	.000	.500	.756	.000	-.189	-.866	.866	.189	-1.000**	.000	.[a]	-.500	-1.000**
	Sig. (2-tailed)	1.000	.667	.454	1.000	.879	.333	.333	.879	.000	1.000	.000	.667	.000
	N	3	3	3	3	3	3	3	3	3	3	3	3	3
PC	**Pearson Correlation**	.500	.000	-.982	.500	.655	.500	-1.000**	-.655	.866	.500	.[a]	.000	.866
	Sig. (2-tailed)	.667	1.000	.121	.667	.546	.667	.000	.546	.333	.667	.000	1.000	.333
	N	3	3	3	3	3	3	3	3	3	3	3	3	3
DPC	**Pearson Correlation**	.500	.000	-.982	.500	.655	.500	-1.000**	-.655	.866	.500	.[a]	.000	.866
	Sig. (2-tailed)	.667	1.000	.121	.667	.546	.667	.000	.546	.333	.667	.000	1.000	.333
	N	3	3	3	3	3	3	3	3	3	3	3	3	3
SPC	**Pearson Correlation**	-.500	.000	.982	-.500	-.655	-.500	1.000**	.655	-.866	-.500	.[a]	.000	-.866
	Sig. (2-tailed)	.667	1.000	.121	.667	.546	.667	.000	.546	.333	.667	.000	1.000	.333
	N	3	3	3	3	3	3	3	3	3	3	3	3	3
TIC	**Pearson Correlation**	1.000**	.866	-.655	1.000**	.982	-.500	-.500	-.982	.000	1.000**	.[a]	-.866	.000
	Sig. (2-tailed)	.000	.333	.546	.000	.121	.667	.667	.121	1.000	.000	.000	.333	1.000
	N	3	3	3	3	3	3	3	3	3	3	3	3	3
IOCS	**Pearson on**	.500	.000	-.98	.500	.655	.500	-1.0	-.65	.866	.500	.[a]	.000	.866

C	**Correlation**			2				00**	5					
	Sig. (2-tailed)	.667	1.000	.121	.667	.546	.667	.000	.546	.333	.667	.000	1.000	.333
	N	3	3	3	3	3	3	3	3	3	3	3	3	3

		RLP14	**RLP15**	**RLP16**	**RLP17**	**RLP18**	**RLS1**	**RLS2**	**RLS3**	**RLS4**	**RLS5**	**RLM1**	**RLM2**	**RLM3**
OTC	**Pearson Correlation**	.756	.945	1.000**	-.982	-.945	.189	.945	.945	.982	-.189	.500	.189	.189
	Sig. (2-tailed)	.454	.212	.000	.121	.212	.879	.212	.212	.121	.879	.667	.879	.879
	N	3	3	3	3	3	3	3	3	3	3	3	3	3
ARC	**Pearson Correlation**	-.500	.500	.189	.000	-.500	1.000**	.500	.500	.000	-1.000**	.945	1.000**	1.000**
	Sig. (2-tailed)	.667	.667	.879	1.000	.667	.000	.667	.667	1.000	.000	.212	.000	.000
	N	3	3	3	3	3	3	3	3	3	3	3	3	3
OBC	**Pearson Correlation**	.189	-.756	-.500	.327	.756	-.945	-.756	-.756	-.327	.945	-1.000**	-.945	-.945
	Sig. (2-tailed)	.879	.454	.667	.788	.454	.212	.454	.454	.788	.212	.000	.212	.212
	N	3	3	3	3	3	3	3	3	3	3	3	3	3
TIC	**Pearson Correlation**	-.866	-.866	-.982	1.000**	.866	.000	-.866	-.866	-1.000**	.000	-.327	.000	.000
	Sig. (2-tailed)	.333	.333	.121	.000	.333	1.000	.333	.333	.000	1.000	.788	1.000	1.000
	N	3	3	3	3	3	3	3	3	3	3	3	3	3

		RLM4	**RLD1**	**RLD2**	**RLD3**	**RSS4**	**RSR1**	**AGP3**	**AGS2**	**AGD3**	**AGR1**	**AGR2**	**ASP1**	**ASR1**

FGWC	**Pearson Correlation**	-.982	.000	.000	.655	.655	-1.000**	-.500	.866	.500	.655	.655	.655	-.655
	Sig. (2-tailed)	.121	1.000	1.000	.546	.546	.000	.667	.333	.667	.546	.546	.546	.546
	N	3	3	3	3	3	3	3	3	3	3	3	3	3
OTC	**Pearson Correlation**	.500	.756	.756	.143	-1.000**	.655	-.327	-.189	-.982	-1.000**	-1.000**	-1.000**	-.143
	Sig. (2-tailed)	.667	.454	.454	.909	.000	.546	.788	.879	.121	.000	.000	.000	.909
	N	3	3	3	3	3	3	3	3	3	3	3	3	3
CPMC	**Pearson Correlation**	-.982	.000	.000	.655	.655	-1.000**	-.500	.866	.500	.655	.655	.655	-.655
	Sig. (2-tailed)	.121	1.000	1.000	.546	.546	.000	.667	.333	.667	.546	.546	.546	.546
	N	3	3	3	3	3	3	3	3	3	3	3	3	3
IPEC	**Pearson Correlation**	-.982	.000	.000	.655	.655	-1.000**	-.500	.866	.500	.655	.655	.655	-.655
	Sig. (2-tailed)	.121	1.000	1.000	.546	.546	.000	.667	.333	.667	.546	.546	.546	.546
	N	3	3	3	3	3	3	3	3	3	3	3	3	3
ARC	**Pearson Correlation**	.945	-.500	-.500	-.945	-.189	.866	.866	-1.000**	.000	-.189	-.189	-.189	.945
	Sig. (2-tailed)	.212	.667	.667	.212	.879	.333	.333	.000	1.000	.879	.879	.879	.212
	N	3	3	3	3	3	3	3	3	3	3	3	3	3
PC	**Pearson Correlation**	-.982	.000	.000	.655	.655	-1.000**	-.500	.866	.500	.655	.655	.655	-.655
	Sig. (2-tailed)	.121	1.000	1.000	.546	.546	.000	.667	.333	.667	.546	.546	.546	.546

	N	3	3	3	3	3	3	3	3	3	3	3	3	3
DPC	**Pearson Correlation**	-.982	.000	.000	.655	.655	-1.000**	-.500	.866	.500	.655	.655	.655	-.655
	Sig. (2-tailed)	.121	1.000	1.000	.546	.546	.000	.667	.333	.667	.546	.546	.546	.546
	N	3	3	3	3	3	3	3	3	3	3	3	3	3
SPC	**Pearson Correlation**	.982	.000	.000	-.655	-.655	1.000**	.500	-.866	-.500	-.655	-.655	-.655	.655
	Sig. (2-tailed)	.121	1.000	1.000	.546	.546	.000	.667	.333	.667	.546	.546	.546	.546
	N	3	3	3	3	3	3	3	3	3	3	3	3	3
OBC	**Pearson Correlation**	-1.000**	.189	.189	.786	.500	-.982	-.655	.945	.327	.500	.500	.500	-.786
	Sig. (2-tailed)	.000	.879	.879	.425	.667	.121	.546	.212	.788	.667	.667	.667	.425
	N	3	3	3	3	3	3	3	3	3	3	3	3	3
TIC	**Pearson Correlation**	-.327	-.866	-.866	-.327	.982	-.500	.500	.000	1.000**	.982	.982	.982	.327
	Sig. (2-tailed)	.788	.333	.333	.788	.121	.667	.667	1.000	.000	.121	.121	.121	.788
	N	3	3	3	3	3	3	3	3	3	3	3	3	3
IOCSC	**Pearson Correlation**	-.982	.000	.000	.655	.655	-1.000**	-.500	.866	.500	.655	.655	.655	-.655
	Sig. (2-tailed)	.121	1.000	1.000	.546	.546	.000	.667	.333	.667	.546	.546	.546	.546
	N	3	3	3	3	3	3	3	3	3	3	3	3	3

**. Correlation is significant at the 0.01 level (2-tailed).
a. Cannot be computed because at least one of the variables is constant.

DISCUSSION AND CONCLUSION

This research proposed a model that provides an overview of the CFPLR model used for orchid supply chain as an exemplary case study. It presented supply chain collaboration among suppliers/vendors in orchid industry. The aim of the model development was to ensure that it may be used as a fundamental basis to integrate supply chain for all suppliers or vendors in orchid industry. By integrating supply chain in orchid and improving collaboration in the supply chain, it can lead to better supply chain performance and effective supply chain management. This is consistent with study of Jermsittiparsert & Rungsrisawat (2019) which indicated that collaboration and information sharing among SMEs in the supply chain results in amelioration of operational performance contributing to overall improvement in supply chain performance. In developing the supply chain performance measurements, this research used subjective rating scales and objective performance measures to indicate the measurements and correlations of supply chain performance and supply chain cost. Different measures evaluate different aspects of supply chain collaboration using the CFPLR model. The results revealed that there were some correlations between supply chain performance and cost.

The CFPLR process champions consumer-based forecasting. It helps trading partners improve the effectiveness and efficiency of supply chain by applying strategic learning addressing consumer needs, competitive learning, and marketplace factors for orchids supply chain. This is important as CFPLR can aide in supplier to consumer integration leading to achieving competitive advantage. Sriyakul et al. (2019) stressed the significance of supplier-customer integration which affects operational and supply chain performance. The CFPLR provides an important map to guide execution across all points of the supply chain, from warehouse to shelf. It serves as a vehicle to keep plans continuing, taking into account changes, modifications, and exceptions. The performance results tracked serve as key learning to guide future plan development.

This research proposed a CFPLR model for orchid supply chain which is modified from CPFR model used in various industries. Logistics is adapted in this model for cost reduction and customer service. As this research focused on developing CFPLR model for orchid supply chain only, further research can be done to apply CFPLR model in other agricultural products. Moreover, as the scope of this research was in Thailand, this research could be further extended and built on to include other countries in the southeast region. A study by Ali et al. (2017) was conducted on information sharing and collaboration in a major European supermarket in Germany and it revealed that information sharing amounts to an effective supply chain and cost saving for the manufacturer and retailer. Hence, CFPLR model could potentially be applied in other industries such as service and retailing to investigate further benefits of employing CFPLR in businesses.

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